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CONTROL OF ARROYO FLOODS AT ALBUQUERQUE, NEW MEXICO

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WATERWAYS DIVISION

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CONTROL OF ARROYO FLOODS AT ALBUQUERQUE, NEW MEXICO

Rufus H. Carter, Jr., M. ASCE¹

SYNOPSIS

Arroyos which drain the east mesa at Albuquerque, New Mexico, and the adjacent mountain face are dry most of the time. Following thunderstorms of high intensity, flows of short duration but high peak debouche onto valley lands and, in the absence of natural channels to Rio Grande, flooding results. After consideration of all possible ways to control floods, two diversion channels were designed to convey flood flows to the north and to the south around the densely populated high value lands. At present price levels, the total cost of construction would be about \$11.5 million. The overall benefit-cost ratio exceeds 2.5 to 1.

A study of flood problems along the main stem and tributaries of the Rio Grande at and in the vicinity of Albuquerque, New Mexico was authorized by the Committee on Public Works, United States Senate in August, 1950, and by the Committee on Public Works, House of Representatives, United States, in June 1952. Subsequent to the later directive, funds were made available, the study was made and a report dated June 20, 1953, was submitted by the Albuquerque District, Corps of Engineers. This report is the basis for authorization of work included in the Flood Control Act of 1954. The text of this report has been published as House Document No. 464, 83d Congress.

Local geographic terminology is descriptive and identifies the west mesa, the east mesa or heights, and the lowlands, which includes the south valley, downtown, and the north valley. (See figure 1) For convenience these terms will be used during this discussion.

The area under consideration comprises the watershed of the ephemeral streams on the east mesa, along a 15-mile reach of the Rio Grande at and in the vicinity of Albuquerque. The combined area of these tributaries is about 260 square miles. The crest of the Sandia Mountains is the outer limit of most of the drainage area. Cliffs from 3,000 to 4,000 feet in height are the prominent feature on the west face of the mountains. Except for Tijeras Canyon most of the tributaries originate on the precipitous western face of the Sandias. None of the tributaries has a natural water course across the valley floor to Rio Grande; the only existing outlets to Rio Grande are the drains, of limited capacity, constructed by the Middle Rio Grande Conservancy District about 20 years ago.

The Rio Grande Valley is said to be the oldest continuously settled region in the United States. As early as 1100 A.D. numerous Indian pueblos were supported by irrigated agriculture along the Rio Grande and its tributaries. It was at the Pueblo of Tiguex, about 20 miles north of Albuquerque, that

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Coronado and his band of intrepid Spanish explorers spent the winter of 1540-41. Albuquerque (Old Town) was founded in 1706. The Santa Fe railroad built into Albuquerque in 1880 and "new" Albuquerque came into being. As a municipality Albuquerque grew slowly but steadily, by 1940 the population had reached 35,449. In 1950 there were 96,815 inhabitants in corporate Albuquerque; Albuquerque and vicinity with more than 100,000 population was designated a metropolitan area following the 1950 census. At present (May 1955) the population of corporate Albuquerque is estimated at 163,000.

From a community of farmers and stockmen, Albuquerque has developed as a trade center. At present, the expansion in government and tourist trade are the dominant factors affecting growth in Albuquerque. Albuquerque is on the main line of the Atchison, Topeka and Santa Fe Railway. Two transcontinental bus lines, three intrastate companies and several interstate trucking firms operate in Albuquerque. Four air lines serve the area. Electricity and gas are distributed in the area by private utility companies. Water for domestic use is produced and distributed by the city.

Average annual precipitation, based on 79 years of record at the Albuquerque office of the Weather Bureau, is 8.27 inches. About one-third of this amount occurs in July and August, often as thunderstorms of high intensity. Precipitation in the form of snow is not a problem.

All the arroyos which drain the east mesa and mountains are dry most of the time. However, following thunderstorms of high intensity and even moderate duration, flows of short duration but high peak result. An historical item of interest, illustrating the intensity of rainfall which has occurred, appeared in the Albuquerque Morning Democrat of Wednesday, July 17, 1889; According to the Democrat "A water spout struck the mesa, three miles east of Albuquerque, Monday, and in less than ten minutes a lake two feet deep covered the table land for several miles." While the accuracy of this statement is subject to question, it does illustrate the rapidity with which arroyos can be filled to overflowing by a sudden torrential storm. Except for Tijeras Arroyo there are no discharge records. Estimates of peak discharges on some of the larger recent floods have been computed from high water marks by the slope-area method.

On Embudo Arroyo, one of the larger east mesa tributaries, major floods occurred in September 1929, July 1950, August 1951, and June 1952. Isohyets of the June 1952 storm are shown in figure 2. There was coincidental flooding in all east mesa arroyos.

For design purposes and after searching the record, a storm that occurred at Las Cruces, New Mexico on August 29-30, 1935, was selected as the most intense storm likely to occur over the east mesa. At its center this storm dumped a total of 9.25 inches of rain; 2.52 inches of which occurred in the first hour. While Albuquerque and Las Cruces are both in the general trajectory of the moist Gulf air flowing up the Rio Grande Valley, Albuquerque is 1,000 feet higher; accordingly the storm was appropriately reduced. Resulting hydrographs provided the bases for the design floods.

In the absence of natural water courses across the valley floor to Rio Grande all flows from the east mesa debouch upon the valley area where they remain until they are dissipated by evaporation and seepage, and through the limited facilities of existing drains.

With the recent rapid expansion in population, valley areas that were rural are now within the corporate limits of the city and farm lands are now densely populated. Large areas of one-time mesa land are closely spotted with water-proof roofs and are minutely dissected with impervious pavements. In the

light of flood hazards, these mutually aggravating conditions together with a rapid but sound increase in property values have created a condition that is not readily tolerable. It is notable that rapid growth is continuing. The total estimated value within the limits of probable flooding is about \$170 million at today's prices.

Damages in the heights areas on the east mesa due to flooding are limited to interruption of traffic flow, the resulting unsightly condition of streets and yards, some erosion and failure of street surfaces where subsurface support is inadequate, and some minor inundation in and around buildings. The real flood problem is in the lowlands, and concentrated in the low-lying areas of the valley, inundation to varying degrees causes major damage. The June 1952 flood caused an estimated damage of about \$350,000. Damages in the lowlands are more nearly a function of flood volume than they are of peak flows. As a result of surveys of actual flood damages, it has been found that the losses by flooding in the heights are about 6 per cent of the losses in the lowlands. It has been estimated that the storm from which the design flood was derived would cause about \$24 million in direct flood damages in the valley area. The flood would cover over 5,300 acres, including the principal business district and large residential areas extending from the South Valley to the North Valley areas. Practically the entire business district would be inundated. Gross average annual damages were found to be a little more than \$1 million, based on current price levels.

A number of schemes for the reduction and elimination of flood damages were considered. These included reservoirs, diversions, pressure conduits, and floodways. Evacuation of the flood plain was also considered.

Following a review of testimony offered at a public hearing and after due consideration of all possible ways of controlling flood flows, it became apparent that some types of channels to the river would be necessary in any feasible plan. The basic plan as finally developed is shown on figure 1, and is composed of the North Diversion Channel and the South Diversion Channel. These channels would be located on high ground east of and parallel to the valley.

The North Diversion Channel would originate in Campus Wash near the Meteoritics Building on the campus of the University of New Mexico. The channel would be concrete-lined and would traverse the end of a ridge and pass into Embudo Arroyo. Under design flows of 5,300 cubic feet per second, supercritical velocity of about 23.5 fps would prevail. The high velocity is desirable to reduce backwater and forbid sedimentation in the channel. A typical section is shown in figure 3.

At Embudo Arroyo a dike would be constructed; a ponding area and silt trap would thus be formed. A crosstown thoroughfare and some utility lines would require relocation.

Northward from Embudo Arroyo the channel would be on top of and follow along the bluffs. A typical section is shown in figure 3. Provision would be made for the entrance of all intercepted watercourses. At deep arroyo crossings the same treatment would be used as at Embudo Arroyo. The slopes of the channel were selected to maintain subcritical velocities. A uniform section has been used throughout; the channel capacity increases from 22,000 to 43,000 cubic feet per second and is attained by increasing the slope of the flow line.

At the north end of the North Diversion Channel at the Alameda Drop Structure, flow would pass from a trapezoidal section to a rectangular section. The drop of about 32.5 feet would occur in four 14' x 14' barrels of a concrete box culvert with stilling basin. Edith Boulevard, the main line of

the AT & SF railway, and U. S. Highway 85 would be carried on the box culvert. The elevation of the inside of the top of the culvert would be three feet above the sill on the lower end of the stilling basin.

From the stilling basin flow would go to Rio Grande between diverging dikes.

The South Diversion Channel would begin near the Lincoln Junior High School. The alignment is generally southward for about five miles, below the line of bluffs at the east edge of the valley area. Typical sections are shown in figure 4. Velocities are all subcritical. Channel capacity varies from 1,500 cubic feet per second at the upper end to 5,400 cubic feet per second at the entrance of the outfall chute. Conventional box culverts will be required at Miles Road, the Kirtland and Sandia railroad spurs, and South Broadway, which is alternative to U. S. Highway 85.

From high ground south of Tijeras Canyon, a levee would divert arroyo flows up to 20,000 cubic feet per second northward to the lower end of the South Channel at the entrance of the outfall chute.

From the confluence of the South Diversion Channel with the lower end of the Tijeras Arroyo Diversion levee, on high ground of the Tijeras Canyon Alluvial fan, an outfall channel would convey all flow at supercritical velocities under the main line of the AT & SF Railway and State Highway 47 (South Second Street) and into Rio Grande.

Both diversion channels have been designed to accomodate the accumulated flow from the entire intercepted drainage areas. This means that when, if and as storm sewers are constructed on the east mesa area, these diversion channels can be used as outfall channels for the storm sewers.

At present price levels, it is estimated that the total cost of the North Diversion Channel would be about \$9.4 million and the cost of the South Diversion Channel scheme would be about \$2.1 million. Based on primary benefits alone, the benefit-cost ratio for the North Diversion Channel is 3.04 to 1.00; for the South Diversion Channel scheme the ratio is 1.58 to 1.00.

Under existing statutes local interests are required to participate to a substantial degree in the cost of local protection projects.

Of the total cost of the North and South Channels, local interests will probably be required to pay about one third.

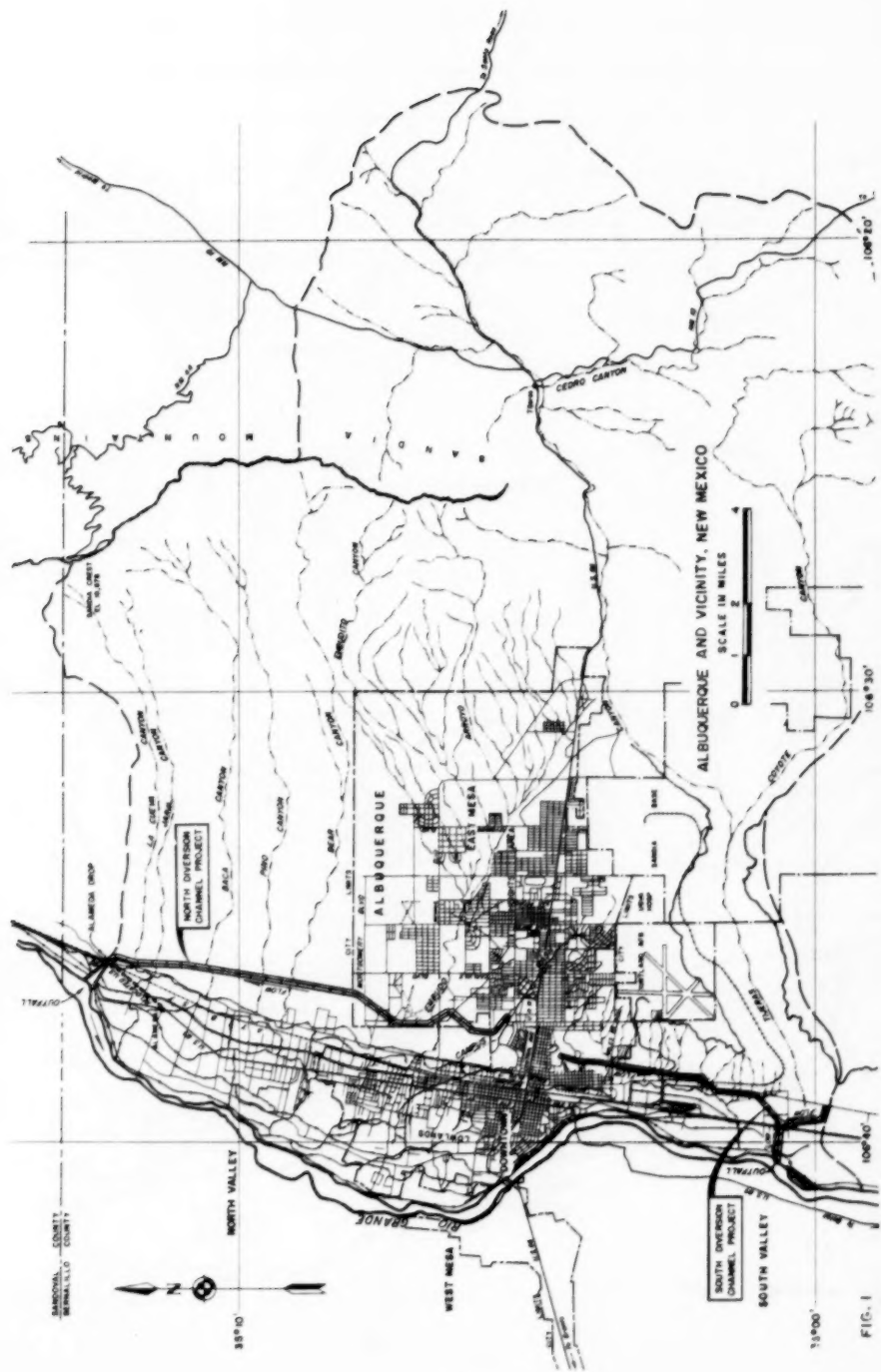
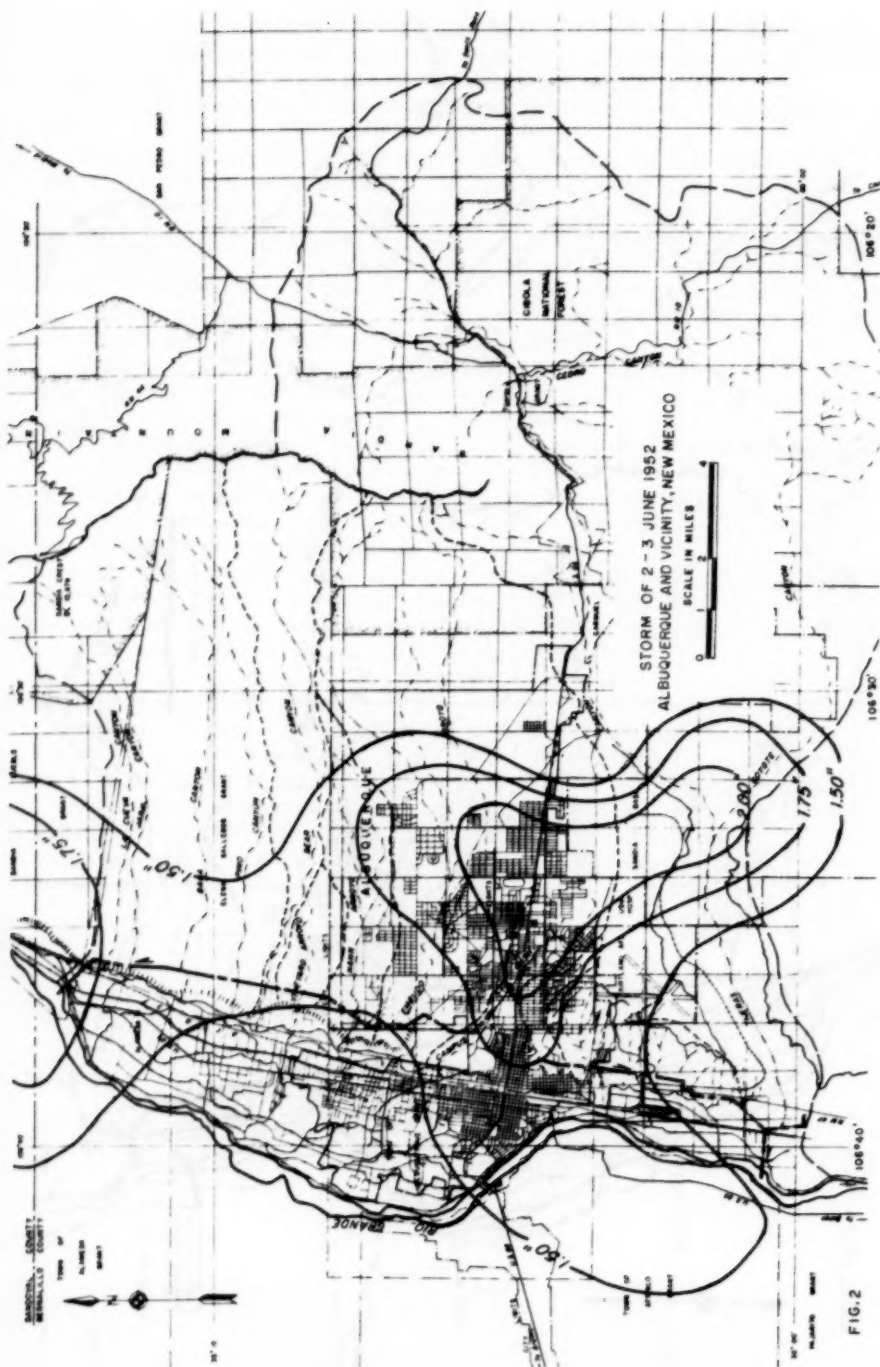
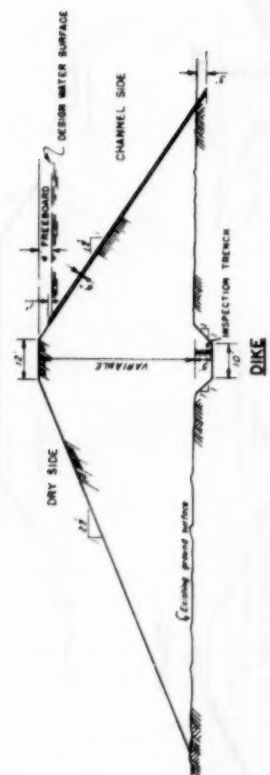
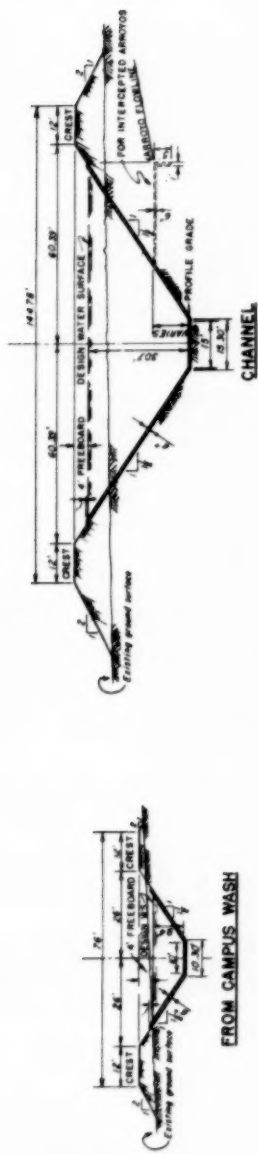


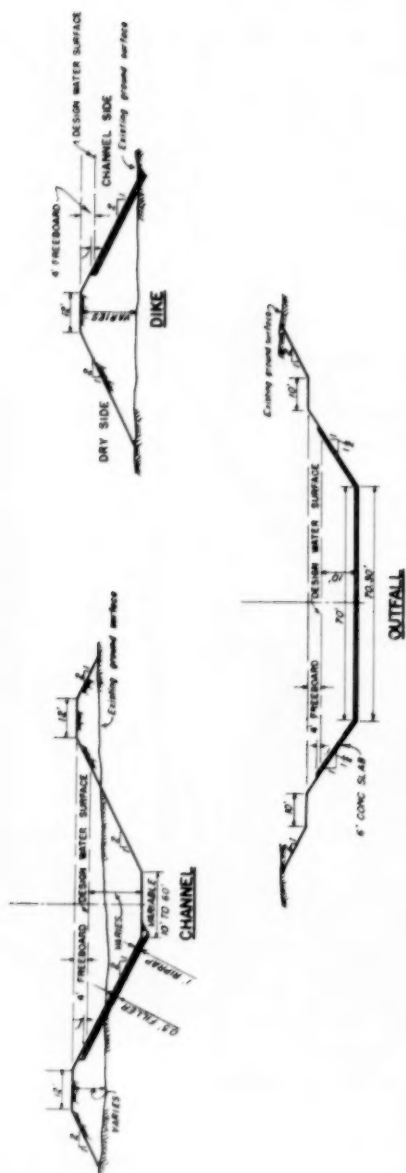
FIG. 1





TYPICAL SECTIONS-NORTH DIVERSION CHANNEL

FIG. 3



TYPICAL SECTIONS—SOUTH DIVERSION CHANNEL

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The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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c. Discussion of several papers, grouped by Divisions.

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